CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows·

1 A linear stepper motor, comprising;

(a) an annular stator structure;

(b) an axially extending, cylindrical, permanent magnet shaft extending coaxially through said annular stator structure; and

(c) said axially extending, cylindrical, permanent magnet shaft having a smooth external surface along a portion thereof with axially alternating N and S poles defined circumferentially in an outer periphery of said portion of said axially extending, cylindrical, smooth, permanent magnet shaft.

2. A linear stepper motor, as defined in Claim 1, wherein: said portion of said axially extending, cylindrical, permanent magnet shaft is hollow.

3. A linear stepper motor, as defined in Claim 1, wherein: said portion of said axially extending, cylindrical, permanent magnet shaft has a solid core.

4. A linear stepper motor, as defined in Claim 3, wherein: said solid core is formed from a ferromagnetic material.

5. A linear stepper motor, as defined in Claim 3, wherein: said solid core is formed from a non-magnetic material.

6. A linear stepper motor, as defined in Claim 1, wherein: said stator structure includes annular disks of a high lubricity material spacing apart elements of said stator structure and serving as bearing surfaces for said axially extending shaft.

7. A linear stepper motor, as defined in Claim 1, wherein: at least said portion

of said axially extending, cylindrical, smooth, permanent magnet shaft is constructed of a single piece of material.

8. A linear stepper motor, as defined in Claim 1, wherein: said axially extending, cylindrical, smooth, permanent magnet shaft can rotate 360° continuously or intermittently in any direction, regardless of whether or not said linear stepper motor is energized.

9. A linear stepper motor, as defined in Claim 1, wherein: said axially extending, cylindrical, smooth, permanent magnet shaft is back-driveable.

10. A linear stepper motor, as defined in Claim 1, wherein: said linear stepper motor is constructed to operate in any orientation.

11. A linear stepper motor, as defined in Claim 1, wherein: said stator structure has modular stator stacks.

12. A linear stepper motor as defined in Claim 1, wherein: said stator structure has conventionally wound coils.

13. A linear stepper motor, as defined in Claim 1, wherein said linear stepper motor includes no bearings.

14. A linear stepper motor, as defined in Claim 1, wherein: said linear stepper motor includes no lead screw and no ball screw.

15. A linear stepper motor, as defined in Claim 1, wherein: said linear stepper motor requires no lubrication of any part thereof.

16. A linear stepper motor, as defined in Claim 1, wherein: said linear stepper motor requires no conversion of rotary motion to linear motion.

17. A fixture for magnetizing axially alternating N and S poles defined circumferentially in a portion of an outer periphery of an axially extending, cylindrical, smooth shaft, said fixture comprising:

(a) a hollow cylindrical mandrel formed from a non-magnetic, non-electrically-conducting material;

(b) a conductive wire disposed in parallel, circumferential channels defined in an outer surface of said mandrel;

(c) a potting compound surrounding said mandrel to secure said conductive wire in place; and

(d) a central bore defined axially and centrally through said mandrel and exposing or nearly exposing said conductive wire; and

(e) said central bore being sized to accept axially inserted therein said portion of said axially extending, cylindrical, smooth shaft.

18. A fixture, as defined in Claim 17, wherein: said conductive wire is placed in said parallel, circumferential channels such that direction of flow in said conductive wire of a direct current in adjacent ones of said parallel, circumferential channels is in opposite directions.

19. A method of providing axially alternating N and S poles in a portion of an axially extending, cylindrical, smooth shaft for a linear stepper motor, comprising:

(a) providing a magnetizing fixture comprising: a hollow cylindrical mandrel formed from a non-magnetic material; a conductive wire disposed in parallel, circumferential channels defined in an outer surface of said mandrel; a potting compound surrounding said mandrel to secure said conductive wire in place; and a central bore defined axially and centrally through said mandrel and exposing or nearly exposing said conductive wire; and said central bore being sized to accept axially inserted therein said portion of said axially extending, cylindrical, smooth shaft;

(b) inserting said portion of said axially extending, cylindrical shaft in said

central bore; and

(c) providing a direct current through said conductive wire said conductive wire is placed in said parallel, circumferential channels such that direction of flow in said conductive wire of a direct current in adjacent ones of said parallel, circumferential channels is in opposite directions.

20. A method, as defined in Claim 19, further comprising: providing said conductive wire placed in said parallel, circumferential channels such that direction of flow in said conductive wire of a direct current in adjacent ones of said parallel, circumferential channels is in opposite directions.

21. A method of manufacturing a magnetizing fixture for magnetizing axially alternating N and S poles defined circumferentially in a portion of an outer periphery of an axially extending, cylindrical, smooth shaft, said method comprising:

(a) providing a plurality of parallel, circumferential channels defined in an outer surface of a cylindrical mandrel formed from a non-magnetic material;

(b) placing a conductive wire in said parallel, circumferential channels;

(c) providing a potting compound surrounding said mandrel to secure said conductive wire in place;

(d) forming a central bore defined axially and centrally through said mandrel and exposing or nearly exposing said conductive wire; and

(e) said central bore being sized to accept axially inserted therein said portion of said axially extending, cylindrical, smooth shaft.

22. A method, as defined in Claim 21, further comprising: providing said conductive wire placed in said parallel, circumferential channels such that direction of flow in said conductive wire of a direct current in adjacent ones of said parallel, circumferential channels is in opposite directions.